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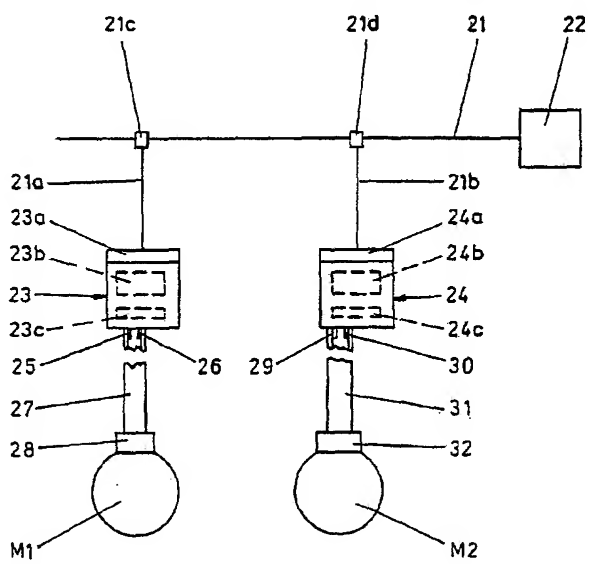

(57) Abstract

The invention relates to an arrangement for effecting detonation of a mass of explosives material comprising an electrical supply source (11), conductor means (12) for conducting electrical signals from said supply source to a detonator (15) and a programmable electronic device (13) in the electrical path between said electrical supply source (11) and said detonator. The programmable electronic device (13) is adapted to receive and to store a programme relating to the desired detonation of the explosive mass and the arrangement includes means for applying a signal to the electronic device (13) to initiate the desired stored programme. In one described embodiment the electronic device (13) includes means (13e) for testing the electrical circuit from the device (13) to the detonator (15) and for transmitting information relating to the programme and said electrical circuit to a signal receiving device via the said conductor means (12).

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"ARRANGEMENT FOR EFFECTING DETONATION OF EXPLOSIVE MATERIALS"

This invention relates to arrangements for detonating explosive materials and has particular application to arrangements for effecting detonation of two or more separated masses of explosive materials in accordance with a predetermined programme.

The present invention seeks to provide a safer and more controllable arrangement for detonating explosive masses than those arrangements practised in the prior art.

According to the present invention there is provided an arrangement for effecting detonation of a mass of explosives material comprising an electrical supply source and conductor means for conducting electrical signals from said supply source to a detonator, characterised by a programmable electronic device in the electrical path between said electrical supply source and said detonator, said programmable electronic device being adapted to receive and to store a programme relating to

the desired detonation of the explosive mass, and means for applying a signal to the electronic device to initiate the desired stored programme.

Arrangements for effecting detonation of two or more separated masses of explosive materials are well known in the art and the separated masses of explosive materials are generally detonated in accordance with a predetermined delay programme, so that the said masses are detonated in a given order. Thus, for many demolition and quarry projects using explosive materials, it is often essential that the explosive masses be detonated in a precise order to achieve a desired effect, with a delay between successive explosions to obtain improved fragmentation of the ground base and to avoid excessive ground vibrations.

In the known arrangements for detonating two or more masses of explosives material it is a practise to run electrical power cables, hereinafter referred to as conductor means, from an electrical supply source to pass adjacent to each of the explosive masses to be detonated and to electrically connect each detonator for each explosive mass to the said conductor means, whereupon a "fire" signal applied to the conductor means by said power source is extended to each and every detonator in the arrangement.

The common detonator used for general demolition and quarry projects are so called "azide" detonators and each of the detonator arrangements will include a pyrotechnic delay element, which is fired by the "fire" signal applied to the conductor means and arranged to burn for a predetermined time before initiating detonation of its respective detonator to effect detonation of the associated explosive mass. The pyrotechnic devices used as delay elements are relatively difficult to set accurately for a specific time delay and to overcome this problem, and obtain a definite time period between successive explosions, it is necessary to have relatively long time periods between the firing of successive masses of explosives material whereupon, in an arrangement

having a large number of masses of explosive material to be detonated, the time period to effect detonation of all the explosive masses can be substantial.

A further problem with arrangements requiring a plurality of explosive masses to be detonated in succession with time delays therebetween arises from the resonance frequency of the material surrounding the explosive masses, and which in the case of a stone quarry will be the resonance frequency of the stone. Thus, when one explosive mass detonates the surrounding stone will resonate and if a second detonation occurs at the wrong time in the ground vibration frequency the amplitude of the vibrations can be increased to such a degree as to cause cracks to open to a bore hole to be detonated and thereby adversely affect the efficacy of the detonation in the cracked bore hole. To avoid the problems of ground vibrations the practice is to further delay the interval between successive detonations to allow the ground resonance to dissipate but, with the inaccuracies of conventional pyrotechnic delay elements, this problem is still often met in practice.

The present invention further seeks to provide an arrangement for effecting detonation of two separate masses of explosive material with a delay therebetween which can be accurately determined.

According to this aspect of the invention there is provided an arrangement comprising a detonator individual to each explosive mass, an electrical signal supply source arranged to transmit electrical signals to a conductor means common to all said detonators, an electrical path individual to each detonator extending to said common conductor means and a programmable electronic device between each detonator and said common conductor means, and wherein each said programmable electronic device is arranged to receive and to store a programme relating to the desired detonation of the explosive mass associated therewith, and means are provided for applying a signal to the common conductor means to initiate the desired

stored programmes of the electronic devices.

In one embodiment the, or each, programmable electronic device is arranged to have a desired programme applied thereto before the device is inserted into the arrangement.

Preferably the, or each, programmable electronic device is arranged to receive and store programme information after being inserted into the arrangement.

Preferably the, or each, programmable electronic device is arrange to be programmed via electrical signals applied to the said common conductor means by said electrical supply source.

In a preferred embodiment the, or each, electronic device is arranged to receive and and store an identification code individual thereto.

In one preferred embodiment the, or each, electronic device includes means for transmitting signals to a signal receiving apparatus via said conductor means.

Preferably the, or each, electronic device is arranged to transmit information stored therein to said signal receiving apparatus on receipt of a command signal from said electrical supply source and said signal receiving apparatus is adapted to compare the information received from the electronic device with a desired predetermined programme stored by said signal receiving apparatus and individual to the transmitting electronic device.

In a preferred embodiment the, or each, electronic device includes means for testing the electrical circuit downstream from said electronic device and, on receipt of a command signal from said electrical supply source, to transmit data relating to the said electrical circuit to said signal receiving apparatus.

Preferably the said signal receiving apparatus includes alarm means arranged to be activated when the information relating to an electrical circuit between an electronic device and its associated detonator is indicative of a fault in said circuit.

In one embodiment the, or each, said electronic device has an identification code applied thereto before the device is inserted into the circuit, each device when inserted into the circuit is arranged to receive and store information relating to the detonation of the explosive mass associated therewith only when said information is preceded by the identification code for that device, and all the electronic devices are arranged to initiate their respective programmes when a "fire" signal is applied by said electrical supply source to said common conductor means.

In one embodiment the "fire" signal applied to said common conductor means is arranged to override or by-pass the identification code for each electronic device whereupon, on transmission of the fire command signal, the programmes for the, or all, the electronic devices are activated.

In one preferred embodiment the electronic device associated with an explosives mass includes an electronic timer, the electronic timer is arranged to start on receipt of a "fire" command signal and at least part of the programme applied to the electronic timer is allowed to run before the electronic device extends a "fire" command signal to the detonator associated with the device.

In one arrangement according to the invention the, or each, electronic device includes capacitor means, charged by electrical power applied to the common conductor and extended to the, or all, the electronic devices, and said capacitor means is discharged when the electrical device is to apply a "fire" command to its respective detonator.

In one embodiment the, or each, detonator comprise an electrical detonator and the electronic device associated with the detonator is arranged to extend an electrical signal to said detonator to initiate said detonator in accordance with the programme stored in said electronic device.

In another embodiment the, or each, detonator is arranged to be detonated by a reaction front travelling along a detonation tube and the electronic device is arranged to initiate detonation of the detonation tube at the desired time in accordance with the programme stored in said device.

In one preferred embodiment the arrangement is characterised by two detonator paths between the, or each, electronic device and its respective detonator, and a second one of said paths is arranged to extend a fire command to the detonator a predeterminded time after the first said path.

Preferably the electronic device is arranged to apply a "fire" command signal to the detonator via said second path a predetermined time after the electronic device applies a "fire" command signal to the first said path.

In one embodiment the second one of said paths includes a pyrotechnic delay device.

In one such embodiment a "fire" command signal is applied to the second said path before the "fire" command signal is applied to the first said path and the delay in applying the "fire" command signal to the first path is substantially equal to the delay time of the pyrotechnic device, whereupon each detonator receives detonation signals simultaneously from both paths.

In another embodiment the, or each, explosive mass has two detonators associated therewith, the arrangement includes a detonation path individual to each detonator and the electronic device associated with the respective explosive mass is arranged to apply a "fire" command to each said path to cause the detonators to detonate in accordance with the pre-set programme stored in the electronic device.

The invention will now be described further by way of example with reference to the accompanying drawings in which;

Fig. 1 shows, diagrammatically, one arrangement for effecting detonation of an explosive mass in accordance with the invention,

Fig. 2 shows, diagrammatically, an arrangement for effecting detonation of a plurality of explosive masses in accordance with the invention, and

Fig. 3 shows, diagrammatically, a further embodiment in accordance with the invention.

In the embodiment illustrated in Fig. 1 an electrical supply source 11 extends electrical signals via a conductor means 12 to an electronic control device 13 and the device 13 is arranged to transmit detonation signals via a connection 14 to a detonator 15 for effecting detonation of an explosive mass M. The electronic control device 13 has an identification code individual thereto stored in a first memory, diagrammatically indicated by numeral 13a, and the device 13 blocks electrical signal transmissions thereto other than those transmissions prefixed by the identification code.

On receipt of signals indicative of its identification code the memory 13a allows subsequent signals to pass to a memory 13b, whereby instruction signals are stored in memory 13b and the memory 13b controls the detonation of the detonator 15 subsequent to receipt of a "fire" signal extended to the device 13 via the conductor 12.

When one function of the electronic control device 13 is to delay the detonation of the detonator 15 for a predetermined time after the device 13 has received the "fire"

command signal, via the conductor means 12, the device 13 conveniently includes electronic timer 13c, which can be pre-set by instruction signals applied to the conductor means 12, following the identification code, and the timer 13c can be thereby set to run for a predetermined time period.

The device 13 also includes capacitor means 13d, arranged to be charged by electrical signals passed through the memory 13a from the conductor means 12, or by signals which by-pass the identification code memory, and the electronic timer 13c will include connections to discharge the capacitor means 13d to the connection 14 when the predetermined time set for the timer 13c has run out.

The device 13 further includes circuit testing and transmitting means 13e, the testing circuit of means 13e being arranged to apply circuit testing signals to the detonator 15 and, to transmit data relating to the efficiency of the circuit downstream of the device 13e back through the conductor 12 to a signal receiving device 16 associated with the electrical supply source 11. The said signal receiving device 16 includes an alarm 17 which is activated by the signal receiving device when the signals received from the testing circuit 13e indicate a fault in the circuitry downstream of said device 13e.

In one mode of operation for the arrangement described thus far the identification code transmitted to the device 13, via the conductor means 12, allows the memory 13b to be addressed and to receive a desired programme for the detonation of detonator 15. The memory 13b pre-sets the time period for the electronic timer to run and prepares to activate the test circuit 13e.

When the desired programme has been entered into the memory 13b further signals from the electrical supply source 11, applied to conductor means 12 and preceding by the identification code for the device 13 are applied to charge the capacitor means 13d.

At any time the testing circuit and transmitting means 13e can be addressed by signals from conductor means 12 and, on

being addressed, the means 13e will apply an inspection signal to the circuit downstream of device 13 and to the capacitor means 13d, and the result of the inspection will be transmitted by the means 13e to the signal receiving device 16.

In the event that a fault has developed in the circuit between the signal transmission means 11 and the device 12 no inspection signal from the means 13e will be received, clearly indicating that a fault has occurred in the electrical circuit upstream of the device 13 and such a fault will be indicated by an alarm activated by the device 16. In the event that a fault has developed in the ignition system downstream of the test circuit 13e the fault will be recognised by the device 16 and an alarm, preferably an alarm identifiable as an alarm indicating a fault downstream of the device 13, will be initiated, and further signals from the device 13e to the device 16 will indicate the state of charging of the capacitor means 13d.

The memory 13b can also be addressed by signals on conductor means 12 and on receipt of an inspection signal, the programme stored by the memory 13b is transmitted to the signal receiving device 16 where said programme can be compared to a stored programme in device 16 to ensure that the programme stored in memory 13b is the desired programme.

Thus immediately prior to applying a "fire" signal to the conductor means 12, the circuit upstream of the device 13 and the circuit downstream of the device 13 can be checked, the condition of the capacitor can be checked and the "fire" signal will only be applied when the inspection results are positive to ensure detonation of the detonator 15.

To effect detonation a "fire" command signal is applied to the device 13 from supply source 11 via conductor means 12, the "fire" command signal may be preceded by the identification code for the device 13 or be applied in such a manner as to by-pass the identification code whereupon a "fire" command signal may be applied simultaneously to a plurality of devices 13 served by the same conductor means 13. On receipt

of the "fire" command signal the timer 13c is initiated and when the delay period set by timer 13c has expired the timer 13c applies a signal to the capacitor means 13d to cause said means 13d to discharge, thus to effect detonation of the detonator 15.

In another mode of operation the signals applied to the conductor 12 to effect charging of the capacitor means 13d may differ from the instruction signals applied between the device 11 and the device 13, by way of example the capacitor charging signals may be at a different frequency or may be modulated in same way, or the circuit may be altered from that illustrated, to allow the capacitor means 13d to be charged without addressing the identification code memory 13a, thus to allow a plurality of capacitor means 13d, for different devices 13, to be charged simultaneously.

In the example illustrated in Fig. 2 a conductor 21, extends electrical signals from a power source 22 to locations adjacent to each of two explosive mass M1, M2 to be detonated. Electrical power is extended from said common conductor 21 to two electronic control devices 23, 24 via connecting lines 21a and 21b respectively, the electronic control device 23 is to be associated with the detonation of explosive mass M1 and the electronic control device 24 is associated with the detonation of the explosive mass M2.

The electrical connecting lines 21a and 21b may be connected to the conductor 21 by any conventional electrical connecting means but, preferably, said connecting lines 21a and 21b connect to the conductor 21 via induction connectors 21c and 21d respectively.

The electronic control device 23 includes an identification code memory 23a upon which an identification code individual to the device 23 is entered before the device 23 is inserted into the arrangement.

The electronic delay device 23 further includes an electronic delay circuit, identified by numeral 23b, and a capacitor 23c. The capacitor 23c, when discharged, is

arranged to generate a spark across two electrodes 25, 26, entered into one end of a detonation tube 27 which is slipped over the electrodes 25, 26 and thus a spark generated across electrodes 25 and 26 causes a reaction of the explosive lining of the tube 27 to effect detonation of a detonator 28 for the explosive mass M1.

In like manner, the electronic device 24 includes an identification code memory 24a, upon which an identification code individual to the device 24 is entered before the device 24 is inserted into the arrangement, an electronic delay circuit, identified by numeral 24b, and a capacitor means 24c. The capacitor means 24c, when discharged, is arranged to generate a spark across two electrodes 29, 30, entered into one end of a detonation tube 31, which is slipped over the electrodes 29,30, and thus the spark generated across electrodes 29 and 30 causes a reaction of the explosive lining of the tube 31 to effect detonation of a detonator 32 for the explosive mass M2.

The electronic control devices 23 and 24 may include any known components for receiving a signal and delaying the transmission of said signal and the said electronic devices 23 and 24 are identical and are individually programmable so that the two devices 23, 24 can be programmed to effect a delay time individual to their respective delay circuit 23b or 24b.

In operation, power from the electrical supply source 22 is extended to the electronic arrangements 23 and 24 to cause the respective capacitors 23c and 24c to be fully charged and discharge of the capacitors 23c and 24c is blocked by the electronic circuits 23b, 24b respectively.

To fire the arrangement a fire command signal is applied by to the common electrical supply source 22 and the firing pulse is extended by the lines 21a, and 21b simultaneously to the electronic devices 23 and 24.

The "fire" command signal by-passes the identification code memories 23a and 24a and is received by the electronic delay circuits 23b and 24b and the preset delay times start to run.

The time delay set for the delay circuit 23b is less than that for the delay circuit 23b and, on the preset delay for delay circuit 23b expiring, the capacitor 23c discharges to generate a spark across the electrodes 25 and 26 to cause the detonation tube 27 to detonate and thereby apply a detonation pulse to the detonator 28 to cause said detonator 28 to detonate the mass of explosives M1.

In identical manner the electronic delay circuit 24b, on receiving the fire command signal, runs for its preset time before allowing capacitor 24c to discharge, to generate a spark across the electrodes 29 and 30 and thereby effect detonation of the detonation tubing 31 to cause detonation of the detonator 32 for the explosive mass M2.

Because the electronic delay circuits 23b, 24b can be accurately set the ground resonance frequency can be measured prior to presetting the delay arrangements and the delay set for said timing circuits can be such as to dampen the ground vibrations caused by the detonation of explosive mass M1.

It will be appreciated that the control devices 23 and 24 may further include the means for testing the circuits downstream of said devices, for testing the charge in the capacitor 23c and 24c and for signalling the results of said inspections back to a receiving device, similar to the arrangement described for Fig. 1.

In the embodiment illustrated in Fig. 3 a common power supply source 50 is extended via conductor 51 and an electronic control device 52 is linked to the conductor 51 by a connection line 53, which connects with the conductor 51 through a snap-on induction connector 54. The snap-on connector 54 may include pins arranged to penetrate the insulation on line 51, whereby to make direct contact with the electrical conductor(s) of line 51, or said snap-on connector 54 may

include a coil into which current is induced by the electro-magnetic field generated by the line 51.

The electronic device 52 include a transformer 55, powered by the current flow from the conductor 51 and connection 53, and which transformer 55 drives an electronic delay circuit 56 and charges two capacitors 57 and 58 within the electronic device 52.

The electronic delay circuit 56 includes a programmable chip 56a, which is arranged to receive and store an identification code individual thereto before the electronic delay arrangement 56 is inserted into a detonation system. When the electronic device 52 is inserted into a detonation system, as shown in Fig. 3, the chip 56a can be addressed by its identification code, via signals on the conductor 51 and connection 53 and a desired delay time individual to that chip 56a can be stored on the chip 56a.

When the electronic device 52 is arranged as shown in Fig. 3, and the chip 56a has been supplied with the desired time delay information from said common line 51, electrical power extended to transformer 55 from line 51, causes the capacitors 57 and 58 to be charged thereby but the said capacitors 57 and 58 are held against discharge by the electronic delay circuit 56 until a fire command signal is received by the delay circuit 56 from line 51 and the delay time programme stored in the chip 56a has expired, when the blocks on capacitors 57 and 58 are removed and the said capacitors 57 and 58 discharge.

The capacitor 57, on discharge, generates a spark across two electrodes 59 and 60, which project from the casing for the electronic device 52. A length of detonation tube 61 has one end slipped over both electrodes 59 and 60 and whereupon, on discharge of capacitor 57, the spark generated across electrodes 59 and 60 cause the detonation lining material in the tube 61 to react, from that end adjacent the electrodes 59 and 60 towards the end of tube 61 remote from electrodes 59 and 60.

The end of tube 61 remote from electrodes 59 and 60 is open to a pyrotechnic delay device 62 for a detonator 63 and thus, when the detonation tube 61 is reacted, the pyrotechnic device is fired and, after a measured period of time determined by the burn delay of the pyrotechnic delay device, effects detonation of the detonator 63.

The capacitor 58, on discharge, generates a spark across two electrodes 64 and 65, protruding from the casing for the electronic device 52. A second length of detonation tubing 66 has one end slipped over the electrodes 64 and 65 and its other end open to the detonator 63 whereupon, on reaction of the detonation tube 66, the reaction wave therefrom directly effects detonation of the detonator 63.

Whilst the two detonation tubes 61 and 66 may remain free between their connections with electronic device 52 and the detonator 63 the said two detonation tubes 61 and 66 are preferably contained within a common sleeve or casing 67 to protect the said tubes 61 and 66 against accidental damage.

It will be seen that with the above described arrangement, wherein both condensers 57 and 58 discharge simultaneously, the capacitor 58, electrodes 64, 65, and detonation tube 66 constitute the first detonation path for detonator 63 and the capacitor 57, electrodes 59 and 60, detonation tube 61 and the pyrotechnic delay device 62 constitute a secondary or back-up path for detonator 63 and whereupon, if detonator 63 should fail to detonate on receipt of the reaction wave from detonation tube 66, the second detonation path will ensure detonation of the detonator 63.

In another arrangement the chip 56a may be programmed with two time delays, whereupon the capacitor 57 is discharged when the first time delay has expired and the capacitor 58 is discharged after the second time delay stored on the chip 56a. Thus, by this means, if the second time delay stored on the chip 56 is equal to the time delay of the pyrotechnic delay device 62 the reaction wave down the detonation tube 66 will act on the detonator 63 at the same time as the pyrotechnic

delay device 62 acts thereon, again to ensure detonation of the detonator 63.

In another arrangement the second delay stored on the chip 56a may delay discharge of the capacitor 58 until after the time period delay afforded by the pyrotechnic delay device 62, whereupon the capacitor 58, electrode 64, 65, and detonation tube 66 constitute the second, or back-up, detonation path for the detonator 63.

In practise, the conductor 51 may have any number of electronic control devices 52 applied thereto, each of the electronic delay arrangements 52 will have its individual identification code pre-programmed thereinto and whereupon the desired delay for each electronic delay arrangement 52 can be supplied and stored on the respective chips 56a by signals on conductor 51.

The electronic control devices 52 are preferably so spaced from the masses of explosive material to be detonated as to be safe from blast effects, falling debris and ground shocks, so as to be recoverable and reusable and, after use, the chips 56a can be wiped clean of information ready to receive a new identification code for use in a new detonation system.

Once again the arrangement illustrated in Fig. 3 may include means for checking the stored programme of each device 52, and means for checking and signalling the condition of the capacitors 57 and 58, in similar manner to that described with respect of the arrangement illustrated in Fig. 1.

It is well know in the art to use two detonators for each explosive mass, generally applied one to the top and one to the bottom of the explosive mass, so that if one detonator should fail the explosive mass will be detonated by the second detonator and this practise of using two detonators for each explosive mass can be readily incorporated into the arrangements proposed by the present invention.

Thus, by way of example, two arrangements as described and illustrated in Fig. 1 each arrangement having its own

connection to conductor 51, and being arranged to detonate its own detonator may be provided for each explosive mass.

In another embodiment the capacitor means 13d may include two capacitors, each being linked via its own connection 14 to a detonator individual thereto, and whereupon when the delay timer has run out both capacitors discharge to detonate their respective detonators.

In similar manner the arrangement described with respect to Fig. 3 may be duplicated to effect detonation of two, spaced apart detonators associated with a common explosive mass.

CLAIMS

1. An arrangement for effecting detonation of a mass of explosives material comprising an electrical supply source and conductor means for conducting electrical signals from said supply source to a detonator, characterised by a programmable electronic device in the electrical path between said electrical supply source and said detonator, said programmable electronic device being adapted to receive and to store a programme relating to the desired detonation of the explosive mass, and means for applying a signal to the electronic device to initiate the desired stored programme.

2. An arrangement for effecting the controlled detonation of a plurality of explosives masses comprising a detonator individual to each explosive mass, an electrical signal supply source arranged to transmit electrical signals to a conductor means common to all said detonators, an electrical path individual to each detonator extending to said common conductor means and a programmable electronic device between each detonator and said common conductor means, and wherein each said programmable electronic device is arranged to receive and to store a programme relating to the desired detonation of the explosive mass associated therewith, and means are provided for applying a signal to the common conductor means to initiate the desired stored programmes of the electronic devices.

3. An arrangement according to claims 1 or 2, characterised in that the, or each, programmable electronic device is arranged to have a desired programme applied thereto before the device is inserted into the arrangement.

4. An arrangement according to claims 1, 2 or 3, characterised in that the, or each, programmable electronic device is arranged to receive and store programme information after being inserted into the arrangement.

5. An arrangement according to claim 4, characterised in that the, or each, programmable electronic device is arrange to be programmed via electrical signals applied to the said common conductor means by said electrical supply source.

6. An arrangement according to any one of the preceding claims characterised in that the, or each, electronic device is arranged to receive and and store an identification code individual thereto.

7. An arrangement according to any one of the preceding claims characterised in that the, or each, electronic device includes means for transmitting signals to a signal receiving apparatus via said conductor means.

8. An arrangement according to any one of the preceding claims characterised in that the, or each, electronic device is arranged to transmit information stored therein to said signal receiving apparatus on receipt of a command signal from said electrical supply source and said signal receiving apparatus is adapted to compare the information received from the electronic device with a desired predetermined programme stored by said signal receiving apparatus and individual to the transmitting electronic device.

9. An arrangement according to any one of the preceding claims characterised in that the, or each, electronic device includes means for testing the electrical circuit downstream from said electronic device and, on receipt of a command signal from said electrical supply source, to transmit data relating to the said electrical circuit to said signal receiving apparatus.

10. An arrangement according to claim 9, characterised in that the said signal receiving apparatus includes alarm means arranged to be activated when the information relating to an electrical circuit between an electronic device and its associated detonator is indicative of a fault in said circuit.

11. An arrangement for effecting detonation of a plurality of explosive masses according to claim 2 or claims 3 to 10 inclusive when dependant on claim 2, characterised in that each said electronic device has an identification code applied thereto before the device is inserted into the circuit, each device when inserted into the circuit is arranged to receive and store information relating to the detonation of the explosive mass associated therewith only when said information is preceded by the identification code for that device and all the electronic devices are arranged to initiate their respective programmes when a "fire" signal is applied by said electrical supply source to said common conductor means.

12. An arrangement for effecting detonation of a plurality of explosives masses according to claim 11 characterised in that the "fire" signal applied to said common conductor means is arranged to override or by-pass the identification code for each electronic device whereupon, on transmission of the fire command signal, the programmes for all the electronic devices are activated simultaneously.

13. An arrangement for effecting detonation of a mass of explosive material according to any on of the preceding claims, characterised in that the electronic device associated with the explosives mass includes an electronic timer, the electronic timer is arranged to start on receipt of a "fire" command signal and at least part of the programme applied to the electronic timer is allowed to run before the electronic device extends a "fire" command signal to the detonator associated with the device.

14. An arrangement according to any one of the preceding claims characterised in that the, or each, electronic device includes capacitor means, charged by electrical power applied to the common conductor and extended to the, or all, the electronic devices, and said capacitor means is discharged when the electrical device is to apply a "fire" command for its respective detonator.

15. An arrangement according to any one of the preceding claims wherein the, or each, detonator comprise an electrical detonator and the electronic device associated with the detonator is arranged to extend an electrical signal to said detonator to initiate said detonator in accordance with the programme stored in said electronic device.

16. An arrangement according to any one of claims 1 to 15 inclusive, wherein the, or each, detonator is arranged to be detonated by a reaction front travelling along a detonation tube and the electronic device is arranged to initiate detonation of the detonation tube at the desired time in accordance with the programme stored in said device.

17. An arrangement according to any one of the preceding claims characterised by two detonation paths between the, or each, electronic device and its respective detonator, a second one of said paths being arranged to extend a fire command to the detonator a predetermined time after the first said path.

18. An arrangement according to claim 17, characterised in that the second one of said paths includes a pyrotechnic delay device.

19. An arrangement according to claim 17 or 18 characterised in that a "fire" command signal is applied to the second said path before the "fire" command signal is applied to the first said path and the delay in applying the "fire" command signal to the first path is substantially equal to the delay time of the pyrotechnic device, whereupon both detonators are detonated substantially simultaneously.

20. An arrangement according to any one of the preceding claims characterised in that the, or each, explosive mass has two detonators associated therewith the arrangement includes a detonation path individual to each detonator and the electronic device associated with the respective explosive mass is arranged to apply a "fire" command to each said path to cause the detonators to detonate in accordance with the pre-set programme stored in the electronic device.

21. An arrangement for effecting detonation of a mass of explosives material substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

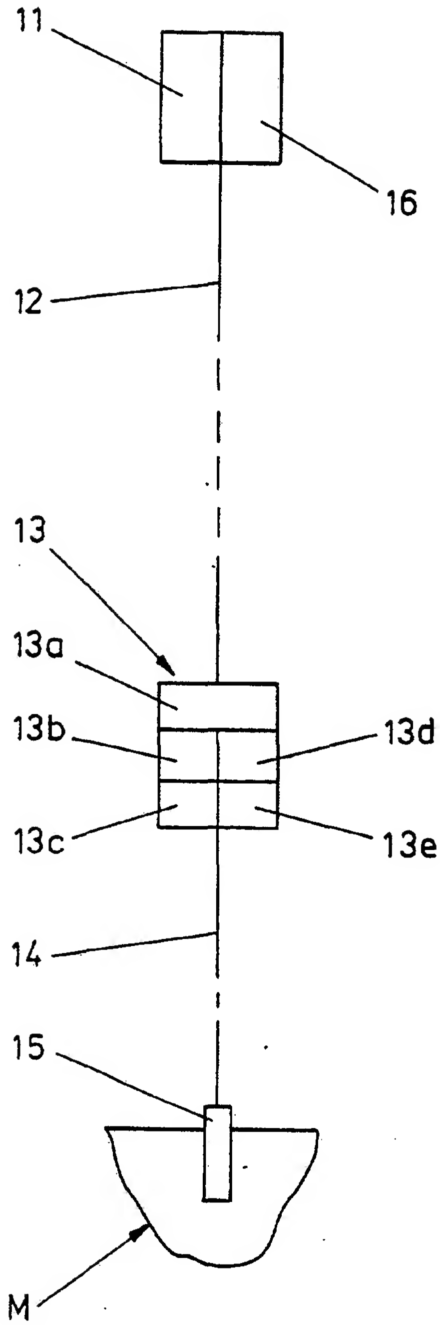
11
16
12
13
13a
13b
13d
13c
13e
14
15
M

FIG. 1

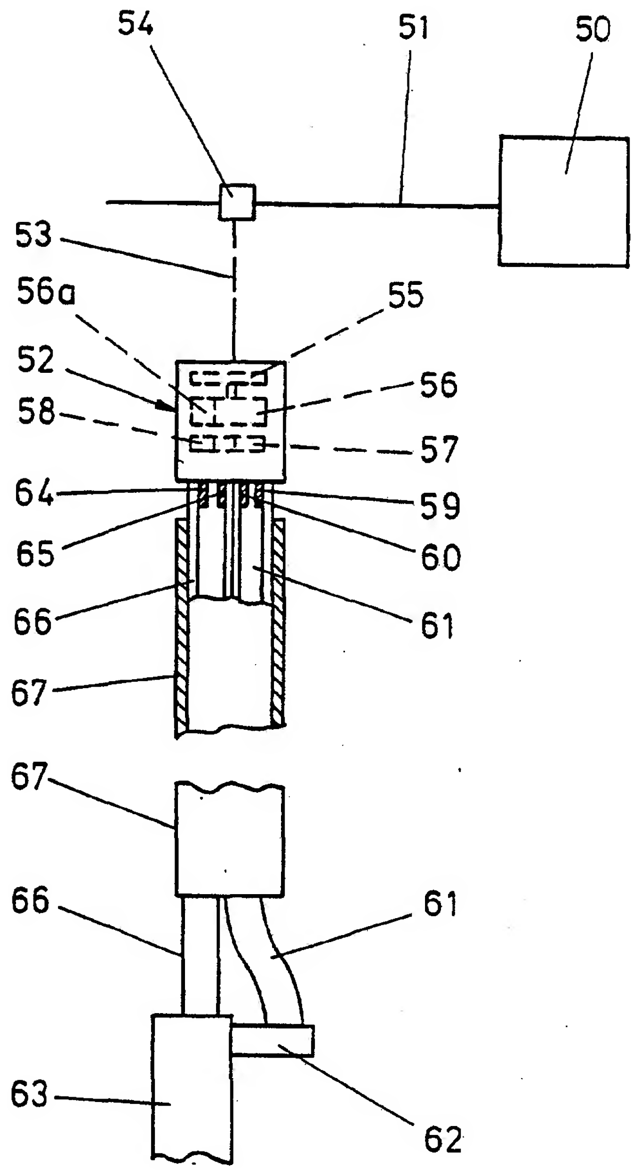
54
51
50
53
56a
55
52
56
58
57
64
59
65
60
66
61
67
67
66
61
63
62

FIG. 3

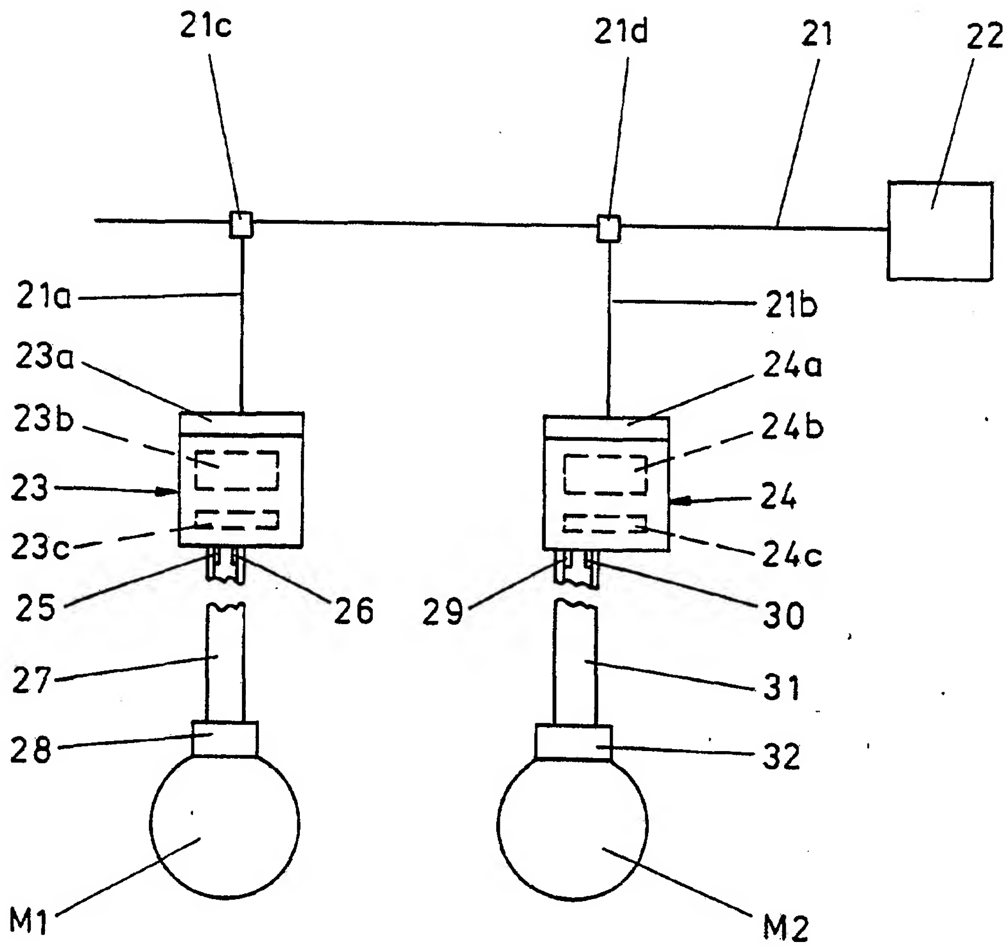
21c
21d
21
22
21a
21b
23a
24a
23b
24b
23
24
23c
24c
25
26
29
30
27
31
28
32
M1
M2

FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00436

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 F42D1/055

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	F42D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category°	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US,A,4 674 047 (TYLER ET AL.) 16 June 1987 see column 1, line 28 - column 4, line 56 see column 5, line 22 - column 6, line 18 see column 7, line 65 - column 8, line 6 see figures 1-3,9	1-11, 13-15,21
Y		16,17,20

Y	US,A,5 001 981 (SHAW) 26 March 1991 see column 2, line 11 - line 35 see column 4, line 30 - line 41 see figure 1	16,17,20

X	EP,A,0 420 673 (CSIR) 3 April 1991 see column 1, line 41 - column 7, line 55 see figure 1	1-5, 7-10,13, 15,21

	-/--	

° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

1

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
18 MAY 1993	27.05.93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	OLSSON B.G.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	EP,A,0 434 883 (UNION ESPANOLA DE EXPLOSIVOS S.A.) 3 July 1991 see page 3, line 24 - page 4, line 27 see figures	1-9,11, 13,21
X	US,A,RE33004 (KIRBY ET AL.) 1 August 1989 see column 2, line 42 - column 5, line 17 see figure 1	1-6,21
A	PROCEEDINGS OF THE 9TH CONFERENCE OF EXPLOSIVES AND BLASTING TECHNIQUE JANUARY 31 - FEBRUARY 4 1983, pages 489 - 496 WORSEY & TYLER 'THE DEVELOPMENT CONCEPT OF THE INTEGRATED ELECTRONIC DETONATOR'	1

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300436
SA 70718

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 18/05/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-4674047	16-06-87	None	
US-A-5001981	26-03-91	None	
EP-A-0420673	03-04-91	AU-B- 636166	22-04-93
		AU-A- 6324490	11-04-91
		CA-A- 2026220	29-03-91
		US-A- 5189246	23-02-93
EP-A-0434883	03-07-91	None	
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		US-A- 4419933	13-12-83
		US-A- 4409897	18-10-83

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82